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GEOGRAPHICAL DISTRIBUTION AT LOW LATITUDES OF CRITICAL FREQUENCIES OF THE F_2 — LAYER

by

L. A. Shchepkin

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GEOGRAPHICAL DISTRIBUTION AT LOW LATITUDES OF CRITICAL FREQUENCIES OF THE F_2 — LAYER

(K voprosu o geograficheskom raspredelenii kriticheskikh chastot sloya F2 na nizhnikh shirotakh)

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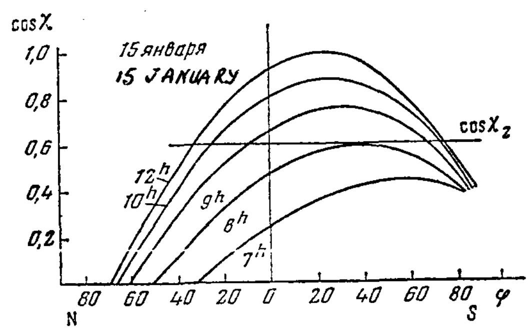
by L. A. Shchepkin

A detailed study of latitude dependence of the F_2-layer's critical frequencies $f_oF2(\varphi)$ permitted to reveal in the course of the last few years a tendency toward a specific dependence upon the height of the Sun, together with a clearly-expressed geomagnetic effect. This finds its sharpest expression in the shifting in the course of a day of the f_oF_2 maximum [1]. A shift of that maximum from low to high latitudes is observed from morning to midday, and after 1400 hours local time — in the reverse direction. The daily course of f_oF_2 also reveals a tendency to vary with the latitude [2], which appears to be dependent upon the geographic as well as the geomagnetic coordinates. A noteworthy particularity of that dependence is the presence of two maxima in the curve of f_oF_2 course, prior and after midday, a rapprochement of these maxima with the rise of the latitude, and their merger into a single midday maximum at a certain latitude. (See Fig. 4 in reference [2]).

In connection with the above, one may also point to the small difference in the value of correlational ratios of f_oF_2 with the geographical and the geomagnetic coordinates, established by Kerblay [3]. All this provides the basis of searching for the causality between the geographical distribution of f_oF_2 at low latitudes and the zenithal angle of the Sun, bearing in mind those anomalies which are usually construed as geomagnetic effects proper.

It was shown in the present author's reference [4], that the existence of two maxima of ion formation intensity is possible in the F region of the ionosphere within a specific interval of values of the height of the Sun, and that at the upper boundary of that value, characterized by the quantity $\cos \chi_2$ (χ — being the Sun's zenithal angle), the upper maximum degenerates into an inflexion, and disappears completely as an extreme at greater heights of the Sun. A transition from one mechanism of F_2-layer maximum formation, similar to that which is given by the theory of the simple layer, to the other, by way of which the F_2-layer maximum is formed in the break away from the maximum of ion formation intensity, may then be expected. This causes a strong subjection in the latter case of the F_2-layer to the effect of electron-ion gas flows, linked with the diffusion, drifts, compressions and expansions of the atmosphere.

Let us discuss from that viewpoint the referred-to tendencies in f_oF_2 and in the latitude variation of the daily course of f_oF_2 at low latitudes. Plotted are in the graph (next page) the curves of the latitude distribution of $\cos \chi$ for a series of hours of the day computed for 15 January. The horizontal line corresponds to a certain value of $\cos \chi_2$, assumingly invariable with the latitude in the near-equatorial region. In the Northern hemisphere, which is the winter hemisphere, there takes place at low latitudes, according to the above considerations, a transition from one to another mechanism of F2-layer formation. A lowering of f_oF2 at latitudes below the transitional because of the break off from the maximum of ion formation of the F2-layer maximum may be linked with such a transition. At latitudes above the transitional a rise of $f_o F2$ may be expected in a direction toward the equator, which is related to the increase of $\cos \chi$. As a result, a maximum of $f_o F_2 (\varphi)$ must form near the transitional latitude. It may be seen from the graph that this maximum must form near the equator in the morning hours (about 06 00 hrs local time) and shift toward the region of higher latitudes in proportion to nearing the midday. After midday hours a reverse shift of the f_oF2 maximum must take place. In the summer hemisphere the F2 - layer maximum must form in the break from the maximum of ion formation through to high latitudes. A tendency to the formation of the $f_oF2 (\varphi)$ maximum may also be perceived in that hemisphere, which is conditioned by the latitude course of $\cos \chi$. The discussed tendency must lead to the formation of a f_oF2 maximum at the same latitude where the quantity $\cos \chi$ is maximum.



The proposed scheme does not provide foundations to assert that the $f_oF2 (\varphi)$ maximum must undergo daily shifts linked with the height of the Sun in the summer hemisphere. This may help in bringing forth specific judgements on the causes of the daily shift of the examined maximum in comparing the patterns of latitude distribution of F2 - layer's critical frequencies in both hemispheres at different hours of the day.

It follows from the above considerations that the $f_o F2$ (φ) maxima may form in the summer and winter hemispheres not only on account of electron-ion gas flows in an horizontal direction, but also as a consequence of the above-described variation in the conditions of F2-layer formation as a function of cos χ at various latitudes. At the same time the latter cause must act differently in the summer and winter hemispheres. The difference in the mechanisms of of $f_o F2$ (φ) maximum formation in different hemispheres may also appear to be the cause of the fact, that this maximum is usually greater in the winter hemisphere than in the summer hemisphere [3].

During the equinoctial season the described mechanism must lead to a symmetric formation of $f_o F2$ (φ) maxima in both hemispheres (relatively to the geogrpahical equator), and both maxima must at the same time be formed by the very same mechanism in both hemispheres.

Pursuing similar considerations one may come to the conclusion that the proposed scheme allows to interpret even the above-described pattern of latitude variation of the daily course of $f_o F2$ on the basis of the fundamental process of atmosphere ionization in the F-region. Indeed, the farther from the equator in wintertime, the closer to midday the described transition must take place from the one to the other mechanism of F2-layer formation. The reverse transition must take place in an interval of time symmetrical relative to midday. At a certain latitude $\cos \chi = \cos \chi_2$ is only reached at noon. This is precisely the latitude at which a single large maximum of the daily course of $f_o F2$ is observed in the noon region.

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